

REMARKS

The present Amendment amends claims 34, 37, 44, 45, and 47-59, and leaves claims 35, 36, 38-43, 46, and 60 unchanged. Therefore, the present application has pending claims 34-60.

35 U.S.C. §102 Rejections

Claims 34-36, 38, 42, 44, and 54-60 stand rejected under 35 U.S.C. §102(e) as being unpatentable over U.S. Patent Application Publication No. 2001/0054771 to Wark, et al. ("Wark"). This rejection is traversed for the following reasons.

Applicants submit that features of the present invention, as now more clearly recited in claims 34-36, 38, 42, 44, and 54-60, are not taught or suggested by Wark, whether taken individually or in combination with the other references of record.

Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection

Amendments were made to the claims to more clearly describe features of the present invention. Specifically, amendments were made to the claims to more clearly describe that the present invention is directed to a method of producing a semiconductor device as recited, for example, in independent claim 34.

The present invention, as recited in claim 1, provides a method of producing a semiconductor device, including the steps of forming a plurality of pyramid-shaped bump electrodes, and connecting the pyramid-shaped electrodes to pad electrodes of the semiconductor device. The step of forming the plurality of pyramid-shaped bump electrodes includes forming pyramid-shaped etched holes by anisotropically

etching a base material having a crystal orientation, and filling up the etched pyramid-shaped holes by plating a metal to form the pyramid-shaped bump electrodes, where the shape of the pyramid-shaped bump electrodes is identical to the shape of the etched pyramid-shaped holes. The step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. The prior art does not disclose all these features.

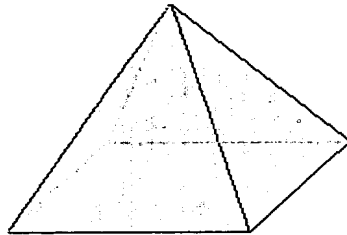
The above described features of the present invention, as now more clearly recited in the claims, are not taught or suggested by any of the references of record, particularly Wark, whether taken individually or in combination with the other references of record.

Wark discloses a method for making projected contact structures for engaging bumped semiconductor devices. However, there is no teaching or suggestion in Wark of the method of producing a semiconductor device of the present invention, as recited in the claims.

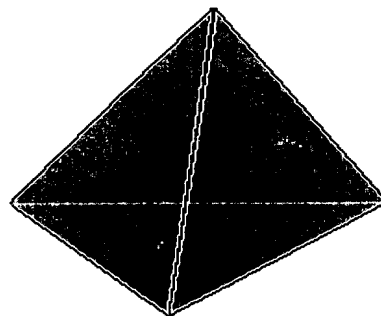
Wark teaches a bumped semiconductor device contact structure including at least one non-planar contact pad having a plurality of projections extending from the contact pad. The projections contact at least one solder ball of a bumped integrated circuit (IC) device, such as a bumped die and a bumped packaged IC device. The projections are arranged to make electrical contact with the solder balls of a bumped IC device without substantially deforming the solder ball. Accordingly, reflow of

solder balls to reform the solder balls is not necessary with the contact pad of Wark. Wark further discloses a method for forming the contact pads by etching a deposition.

One feature of the present invention, as recited in claim 34, includes forming a plurality of pyramid-shaped bump electrodes. Wark does not disclose this feature. As shown below, a pyramid is defined as a space figure having a square base and 4 triangle-shaped sides.



The present invention discloses the use of pyramid-shaped bump electrodes. Wark does not disclose the use of pyramid-shaped bump electrodes. To the contrary, and as shown in Fig. 1A (item 24), Fig. 2B (item 48) and Fig. 12 (item 510), Wark discloses the use of tetrahedron-shaped projections. As shown below, a tetrahedron is defined as a space figure having 4 sides, where each of the 4 sides is a triangle.



A pyramid-shaped bump electrode, as disclosed in the present invention, is not the same as a tetrahedron-shaped bump electrode, as disclosed in Wark.

Furthermore, a “triangular or pyramid-like” projection is not the same as a “pyramid-shaped” bump electrode. With reference to Fig. 1A, Wark describes the projections 24 as “triangular or pyramid-like” structures (paragraph [0042]). A triangular or pyramid-like structure is not the same as the actual shape of a pyramid, as in the present invention. To the contrary, a triangular or pyramid-like structure is an accurate description of the tetrahedron-shaped projections shown in Fig. 1A. In addition, it is clear that Wark intends to describe the projections 24 shown in Fig. 1A as triangular or pyramid-like based on the choice of language (i.e., “the projections 24, (here seen as radially extending, triangular or pyramid-like structures)) (paragraph [0042]).

Another feature of the present invention, as recited in claim 34, includes where the step of forming the plurality of pyramid-shaped bump electrodes includes forming pyramid-shaped etched holes by anisotropically etching a base material having a crystal orientation, and filling up the etched pyramid-shaped holes by plating a metal to form the pyramid-shaped bump electrodes, where the shape of the pyramid-shaped bump electrodes is identical to the shape of the etched pyramid-shaped holes. To support the assertion that Wark teaches forming etched holes by anisotropically etching a base material having a crystal orientation, the Examiner cites paragraph [0052]. However, there is no teaching or suggestion in the cited paragraph, or any other portions of Wark of anisotropically etching a base material to

form pyramid-shaped etched holes, as in the present invention. To support the assertion that Wark teaches filling up the etched holes to form the electrodes, the Examiner cites paragraph [0059]. However, neither the cited paragraph nor any other portion of Wark teaches or suggests filling up etched pyramid-shaped holes to form the pyramid-shaped bump electrodes, where the shape of the pyramid-shaped electrodes is identical to a shape of the etched pyramid-shaped holes, as claimed. More specifically, Wark does not disclose etched pyramid-shaped holes, and further does not disclose where the pyramid-shaped bump electrodes take on the shape identical to the etched pyramid-shaped holes.

Yet another feature of the present invention, as recited in claim 34, includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Wark does not disclose this feature. To support the assertion that Wark discloses connecting bump electrodes to pad electrodes, the Examiner cites Fig. 1A (items 22 and 24), Fig. 1B (items 24 and 26), Fig. 2B (items 42 and 48) and Fig. 12 (items 508 and 510). However, as previously discussed, Wark does not disclose where the connecting pyramid-shaped bump electrodes to pad electrodes, as claimed. To the contrary, Wark discloses the use of tetrahedron-shaped projections rather than pyramid-shaped bumped electrodes, as in the present invention. Furthermore, Wark does not teach or suggest where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base

of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes, in the manner claimed.

Therefore, Wark fails to teach or suggest “forming a plurality of pyramid-shaped bump electrodes of the semiconductor device” as recited in claim 34.

Furthermore, Wark fails to teach or suggest “wherein said step of forming the plurality of pyramid-shaped bump electrodes includes: a step of forming pyramid-shaped etched holes by anisotropically etching a base material having a crystal orientation, and a step of filling up the etched pyramid-shaped holes by plating a metal to form the pyramid-shaped bump electrodes, wherein the shape of the pyramid-shaped bump electrodes is identical to a shape of the etched pyramid-shaped holes” as recited in claim 34.

Yet even further, Wark fails to teach or suggest “wherein the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes” as recited in claim 34.

Therefore, Wark fails to teach or suggest the features of the present invention, as now more clearly recited in the claims. Accordingly, reconsideration and withdrawal of the 35 U.S.C. §102(e) rejection of claims 34-36, 38, 42, 44, and 54-60 are respectfully requested.

The remaining references of record have been studied. Applicants submit that they do not supply any of the deficiencies noted above with respect to the references used in the rejection of claims 34-36, 38, 42, 44, and 54-60.

35 U.S.C. §103 Rejections

Claims 37, 39-41, 43, and 45-53 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Wark in view of U.S. Patent No. 5,643,831 to Ochiai, et al. ("Ochiai"). Claims 37, 39-41, 43, and 45-52 are dependent on claim 34. Therefore, Applicants submit that claims 37, 39-41, 43, and 45-52 are allowable for at least the same reasons as independent claim 34. Regarding the remaining claim 53, this rejection is traversed for the following reasons. Applicants submit that the features of the present invention, as now more clearly recited in claim 53, is not taught or suggested by either Wark or Ochiai, whether taken individually or in combination with each other as suggested by the Examiner. Therefore, Applicants respectfully request the Examiner to reconsider and withdraw this rejection.

Amendments were made to the claims to more clearly describe the features of the present invention. Specifically, the claims were amended to more clearly describe that the present invention is directed to a method of producing a semiconductor device as recited, for example, in independent claim 53.

The present invention, as recited in claim 53, provides a method of producing a semiconductor device including forming a plurality of pyramid-shaped bump electrodes and connecting the pyramid-shaped bump electrodes to pad electrodes of the semiconductor device. The step of forming the plurality of pyramid-shaped

electrodes includes forming a first pattern having openings at positions corresponding to etched holes by etching a first oxidized film formed on a surface of a base material having a crystal orientation, and forming the etched holes by using the first pattern as a mask. The step of forming the plurality of pyramid-shaped electrodes further includes removing the first oxidized film and forming a second oxidized film anew on the etched holes. Also included in the step of forming the plurality of pyramid-shaped electrodes is a step of forming a plated feeding film on the base material having the crystal orientation and on a side surface of each of the etched holes. The step of forming the pyramid-shaped electrodes also includes forming a second pattern of an organic material on the base material having the crystal orientation, so that the etched holes are not covered, and filling up the etched holes by plating a metal film on the plated film on the plated feeding film. The step of forming the pyramid-shaped electrodes further includes forming a gold plated film on the metal film and removing the second pattern of the organic material. The method of the present invention also includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. The prior art does not disclose all these features.

The above described features of the present invention, as now more clearly recited in the claims, are not taught or suggested by any of the references of record.

Specifically, the features are not taught or suggested by either Wark or Ochiai, whether taken individually or in combination with each other.

As previously discussed, Wark discloses a method for making projected contact structures for engaging bumped semiconductor devices. However, there is no teaching or suggestion in Wark of the method of producing a semiconductor device of the present invention, as recited in the claims.

One feature of the present invention, as recited in claim 53, includes forming a plurality of pyramid-shaped bump electrodes. As previously discussed, Wark does not disclose the use of pyramid-shaped bump electrodes. To the contrary, and as shown in Fig. 1A (item 24), Fig. 2B (item 48) and Fig. 12 (item 510), Wark discloses the use of tetrahedron-shaped projections. These tetrahedron-shaped projections are not the same as the pyramid-shaped bump electrodes of the present invention.

Another feature of the present invention, as recited in claim 53, includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Wark does not disclose this feature. To support the assertion that Wark discloses connecting bump electrodes to pad electrodes, the Examiner cites Fig. 1A (items 22 and 24), Fig. 1B (items 24 and 26), Fig. 2B (items 42 and 48) and Fig. 12 (items 508 and 510). However, as previously discussed, Wark does not disclose where the connecting pyramid-shaped bump electrodes to pad electrodes, as claimed. To the contrary, Wark discloses the use of tetrahedron-shaped projections

rather than pyramid-shaped bumped electrodes, as in the present invention.

Furthermore, Wark does not teach or suggest where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes, in the manner claimed.

Therefore, Wark fails to teach or suggest “forming a plurality of pyramid-shaped bump electrodes of the semiconductor device” as recited in claim 53.

Furthermore, Wark fails to teach or suggest “wherein the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes” as recited in claim 53.

The above noted deficiencies of Wark are not supplied by any of the other references, particularly Ochiai. Therefore, combining the teaching of Ochiai with Wark still fails to teach or suggest the features of the present invention, as now more clearly recited in claim 53.

Ochiai discloses a process for forming solder balls on a plate having apertures using solder paste and transferring the solder balls to the semiconductor device. However, there is no teaching or suggestion in Ochiai of the method of producing a semiconductor device of the present invention, as recited in claim 53.

In Ochiai's method, a semiconductor is fabricated using a solder ball forming plate having cavities. The plate is made from a silicon plate having a flat surface in a

crystallographic plane, and an orientation flat in a crystallographic plane. The cavities are formed on the flat surface of the plate by etching, using a mask having openings in the shape of a rhombus, arranged such that one side of the rhombus is generally parallel to the crystallographic plane. As a result, the cavities having a wedge-shaped bottom are formed. The cavities are then filled with a solder paste and are heated to form solder balls in the cavities while the plate is in an inclined position. The solder balls are then transferred from the plate to the semiconductor chip.

One feature of the present invention, as recited in claim 53, includes forming a plurality of pyramid-shaped bump electrodes. Ochiai does not disclose this feature. As shown and described, Ochiai discloses the formation of solder balls, which are quite different from the pyramid-shaped bump electrodes of the present invention.

Another feature of the present invention, as recited in claim 53, includes where the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes. Ochiai does not disclose this feature. As previously discussed, Ochiai does not teach or suggest the formation of pyramid-shaped bump electrodes, as in the present invention. Therefore, Ochiai does not teach or suggest connecting pyramid-shaped bump electrodes to pad electrodes, in the manner claimed.

Therefore, Ochiai fails to teach or suggest "forming a plurality of pyramid-shaped bump electrodes of the semiconductor device" as recited in claim 53.

Furthermore, Ochiai fails to teach or suggest “wherein the step of connecting the pyramid-shaped bump electrodes to the pad electrodes includes: a step of attaching the base of the pyramid-shaped bump electrodes to the pad electrodes, and transferring the pyramid-shaped bump electrodes to the pad electrodes” as recited in claim 53.

Both Wark and Ochiai suffer from the same deficiencies relative to the features of the present invention, as recited in the claims. Therefore, combining the teachings of Wark and Ochiai, in the manner suggested by the Examiner, does not render obvious the features of the present invention, as now more clearly recited in claim 53. Accordingly, reconsideration and withdrawal of the 35 U.S.C. §103(a) rejection of claim 53 as being unpatentable over Wark in view of Ochiai is respectfully requested.

The remaining references of record have been studied. Applicants submit that they do not supply any of the deficiencies noted above with respect to the references used in the rejection of claim 53.

In view of the foregoing amendments and remarks, Applicants submit that claims 34-60 are in condition for allowance. Accordingly, early allowance of claims 34-60 is respectfully requested.

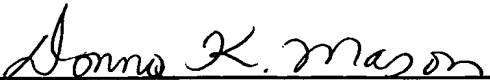
To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, or credit any overpayment of fees, to the

U.S. Application No. 09/462,796

deposit account of Mattingly, Stanger, Malur & Brundidge, P.C., Deposit Account No.
50-1417 (referencing attorney docket no. 500.38090X00).

Respectfully submitted,

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